

Contribution toward a moss flora of Kuwait

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ABSTRACT

Nineteen species of mosses have, so far, been recorded in Kuwait. Fourteen of them belong to the Pottiaceae. Descriptions and photographs of 16 species of this flora are given. *Trichostomopsis haussknechtii* (Jur. et Milde) S. Agnew & Townsend and a *Syntrichia?* species are two new records for Kuwait.

INTRODUCTION

The first work on the bryoflora of Kuwait was that published by El-Saadawi in 1976. This work showed that bryophytes in Kuwait, as in other desert countries, are not widespread, dominated by acrocarpous taxa and that the main elements of the flora belong to the Pottiaceae. Of the then 15 recorded species, 12 belonged to the Pottiaceae and one each to the Fissidentaceae, Bryaceae and Funariaceae. General ecological features, xeromorphic characters and probable origin of the Kuwaiti mosses were also referred to. The review of floristic literature on Kuwait and surrounding countries given by El-Saadawi (1976) showed that work on bryophytes in this area is much neglected.

The aim of the present work is to provide descriptions, photographs and a means of identification of the hitherto recorded Kuwaiti mosses and also to give results of further investigations and collections made by the author during the seasons of 1977 and 1978. This publication is essentially meant to be easily accessible and useful to interested botany students and researchers in this area.

Identification of the mosses was made by M. Bizot (Dijon, France) except for one specimen which was identified by S. Agnew (Aberystwyth, Wales). Synonyms were checked in the *Index Muscorum* (Wijk 1959–69). Other references that were useful in this work are Agnew & Townsend (1970), Agnew & Vondráček (1975).

The classification followed here is mainly in accordance with that in Engler and Prantl's "Die natürlichen Pflanzenfamilien".

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Order 1. Fissidentales

Family Fissidentaceae

- 1.
- Fissidens obtusifolius*

Order 2. Pottiales

Family Pottiaceae

Subfamily Trichostomeae

2. *Barbula vinealis*
3. *B. sp.*
4. *Gymnostomum calcareum*
5. *Timmiella anomala*

Subfamily Pottieae

6. *Pterygoneurum ovatum*
7. *Pottia davalliana*
8. *Aloina rigida*
9. *Crossidium squamigerum*
10. *C. chloronotos*
11. *Trichostomopsis haussknechtii*
12. *Tortula atrovirens*

Order 3. Funariales

Family Funariaceae

13. *Physcomitrium pyriforme*
14. *Funaria hygrometrica*

Order 4. Eubryales

Family Bryaceae

Subfamily Bryoideae

15. *Bryum sp.*
16. *Leptobryum pyriforme*

The total number of mosses hitherto recorded in Kuwait is 19. Two of them, namely *Trichostomopsis haussknechtii* and a *Syntrichia?* species represent new records. Both belong to the Pottiaceae which amounts at present to 14 species. Three of the 19 recorded mosses are not mentioned in the classification since they require further investigation. They are: *Pottia starckeana*, *P. lanceolata* and the *Syntrichia?* species.

The 19 recorded species include native mosses occurring in wadis, garden mosses and greenhouse mosses. Wadi mosses are 14 in number, garden mosses are 6 and greenhouse mosses are only 4. Two of the latter mosses, namely *Physcomitrium pyriforme* and *Leptobryum pyriforme* occur only in greenhouses and are evidently introduced (El-Saadawi 1976). The other two greenhouse mosses are *Funaria hygrometrica* and *Bryum sp.* Both occur also in shaded areas in gardens. The other four garden mosses are *Pterygoneurum ovatum*, *Pottia davalliana*, *P. starckeana* and *P. lanceolata*. The first two of these garden mosses and *Bryum* occur also in wadis. The probability that some of the garden mosses are introduced to Kuwait should be borne in mind. *Bryum* is the only moss which occurs in wadis, greenhouses and in almost every private and public garden in Kuwait. It is also the only moss that has been reported in desert areas away from wadis. All specimens of *Bryum* collected are without sporophytes and have a similar habit and appearance. However, they require further close examination to decide whether they belong to one or more species.

All Kuwaiti mosses occur also in Iraq except *Fissidens obtusifolius*, *Timmiella*

anomala and *Barbula* sp. (no. 3 in the classification). Geographical distribution of mosses is obtained mainly from Wijk (1959–69), Agnew & Vondráček (1975) and El-Saadawi & Badawi (1977).

DESCRIPTIONS AND KEY

The following is a detailed description accompanied by natural photographs of 16 of the recorded mosses. A key to species of the order Pottiales is given. Other orders are represented by only one or two species each, and do not require a key.

1. *Fissidens obtusifolius* Wils. (Plate 1, Figs 1–7)

Dioicous, small, almost prostrate plants. Stems up to 5.5 mm long. Leaves distichous, oblong, alternate, olive green, 0.8 mm long; base vaginant; costa strong, ending below the apex; margin without a border; cells small, quadrate, lower cells slightly larger than upper ones. Seta hardly up to 3.5 mm long, curving to erect position from almost a prostrate stem; capsule terminal, erect, 0.9 mm long, clearly constricted below mouth when dry; lid conical, scarlet red; peristome teeth red.

Occurs only inside wet rock crevices, where it is abundant on calcareous stones and on soil, sometimes in association with blue-green algae.

Wadi Umm Al-Rimam*, 12 and 27 Feb., 8 May 1975, 26 Jan., 5 and 26 March 1976 and 21 Feb. 1978.

(Europe, America, Mexico.)

KEY TO SPECIES OF THE ORDER POTTIALES

I. Nerve excurrent as ± hyaline hair

(A) Peristome present

Autoicous plants; leaf hair up to 2.2 mm long with tiny sparse spines; seta 12–15 mm long. 9. *Crossidium squamigerum*

Dioicous plants; leaf hair 0.25–0.75 mm long, smooth; seta under 5 mm in length. 10. *Crossidium chloronotos*

(B) Gymnostomous, bulbiform plants; seta short; leaf with two large adaxial green sacs. 6. *Pterygoneurum ovatum*

II. Nerve does not extend as a hyaline hair

(A) Nerve excurrent as a mucro

Peristome present; lid obliquely rostrate; calyptra mitriform; seta 10 mm long; apical marginal cells smooth. 12. *Tortula atrovirens*

Gymnostomous; seta under 4 mm in length; apical marginal cells papillose. 7. *Pottia davalliana*

(B) Nerve not excurrent

1. Leaf apex clearly rounded obtuse; leaf stout and rigid with ± hyaline base; seta up to 15 mm long; peristome strongly twisted. 8. *Aloina rigida*

2. Leaf apex obtusely acute

Leaf narrow lanceolate; marginal cells papillose; upper leaves longer than lower; seta only 3 mm long; gymnostomous. 4. *Gymnostomum calcareum*

Leaf lingulate–lanceolate; marginal cells ± smooth; lateral branches growing over the main fruiting one; seta up to 13 mm long; peristome present.

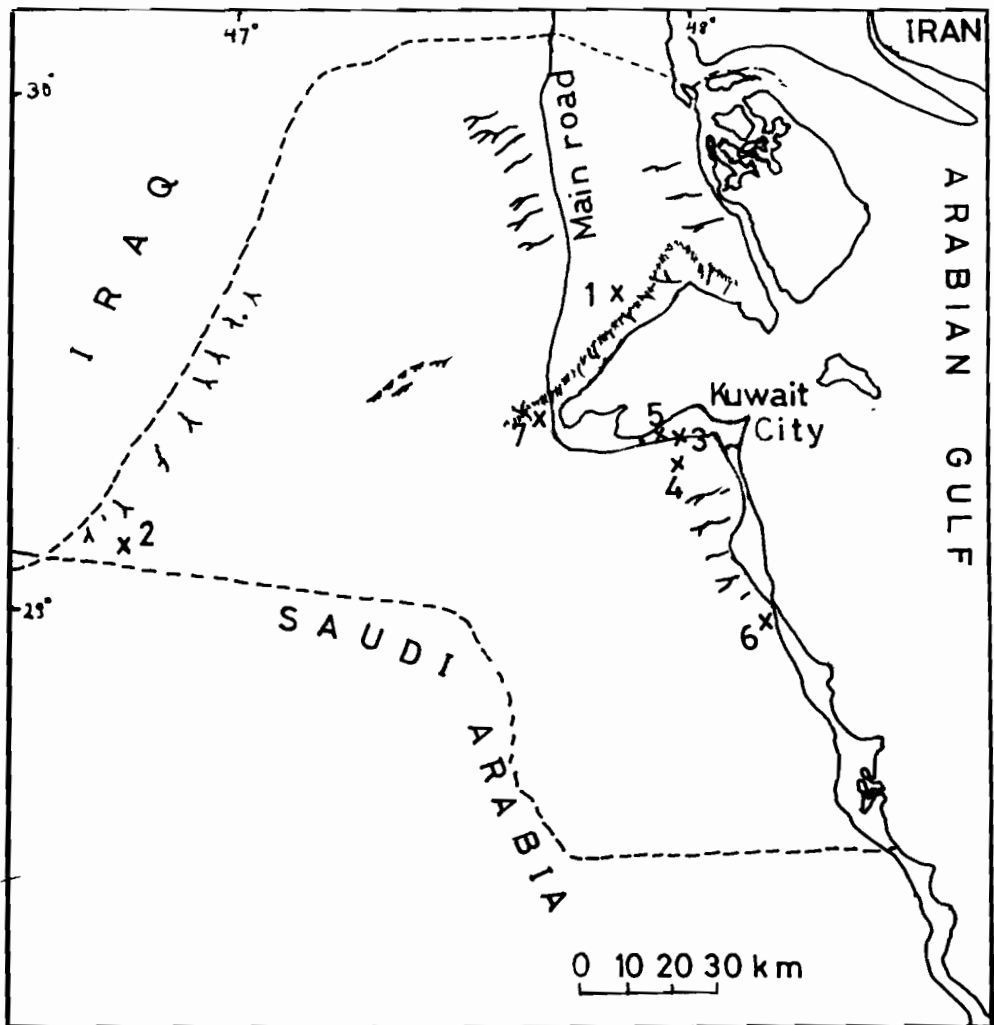
11. *Trichostomopsis haussknechtii*

* For this and other localities of collected mosses see the provided map.

- Leaf lanceolate from a narrow sheathing base; leaves crowded on the short stem; cells very small. 5. *Timmiella anomala*
 Leaves lanceolate from a broad ovate base
 = Plants with a crown of long leaves at stem apex; leaf 2 mm long. 3. *Barbula sp.*
 = Plants with somewhat shorter leaves that do not form a crown at stem apex. 2. *Barbula vinealis*

2. *Barbula vinealis* Brid. (Plate 2, Figs 1-7)

Tufted plants about 1.5 cm high. Leaves vary in colour from olive green to brownish green, patent and recurved when moist, incurved and twist readily when dry, under 2



Map of Kuwait showing collection sites: 1, Umm Al-Rimam; 2, Wadi Al-Batin; 3, Khalidiya; 4, Farawaniya; 5, Shuwaikh; 6, Al-Dba'iyya; 7, Jahra.

mm in length, lanceolate acuminate from a broad ovate base; base vaginant; costa ending below apex, dorsal side brownish.

Abundant at cleft margins and among rocks.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977 and 21 Feb. 1978.

(Europe, Lebanon, Israel, Iraq, Persia, Turkey, Nepal, China, Egypt, N. Africa, N. America, Hawaii.)

3. *Barbula* sp. (Plate 3, Figs 1–5)

Similar to *Barbula vinealis* in habit, leaf shape and colour, but leaves are longer and form a crown at stem apex giving the plant a characteristic peculiar appearance. Crown ca. 5 mm in diameter. Stem ca. 1 cm high. Leaves patent and recurved when moist, imbricate and strongly incurved and twisted when dry.

Forms intermediate between this species and *B. vinealis* occur.

At cleft margins and among rocks but less abundant than *B. vinealis*.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977 and 21 Feb. 1978.

4. *Gymnostomum calcareum* Nees et Hornsch. (Plate 4, Figs 1–11)

Dioicous, dense growing plants of light green or sometimes olive green colour. Fruiting plants uncommon. Stems ca. 5 mm long. Upper leaves longer than the lower, recurved when moist. Leaf narrow lanceolate, 0.7–1 mm long; apex acute or obtuse; costa ending below apex; margin crenulate; upper marginal cells papillose; lower marginal cells longer and smooth. Seta 3 mm long; capsule 0.7 mm long, oval-oblong, thin-walled, light brown; lid 0.5 mm long; calyptra 1.6 mm long, cucullate; gymnostomous.

Abundant in wet rock crevices and extends to just outside the crevices. Plants with sporophytes were found only inside crevices and only in the season of 1976.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 5, 23 and 26 March 1976 and 21 Feb. 1978.

(Europe, Israel, Lebanon, Iraq, Turkey, Persia, Caucasus, Himalaya, Kashmir, China, Egypt, N. Africa, N. & S. America, Australia, New Zealand.)

5. *Timmiella anomala* (B.S.G.) Limpr. (Plate 5, Figs 1–8)

Gregarious, more usually loose or even solitary large plants, 6.5 mm high. Leaves crowded at the apex of a short stem, lanceolate from a narrow sheathing base, up to 3 mm long and 0.8 mm wide, strongly incurled and twisted when dry; apex acute; nerve stout ending below apex; cells rounded–quadrate, very small except at the very base where they are slightly larger.

A rare plant. Inside wet rock crevices in association with *Fissidens* or less usually with *Gymnostomum* and in small dim cave where no other mosses were found.

Wadi Umm Al-Rimam, 26 March 1976.

(Europe, Asia, Africa, America.)

6. *Pterygoneurum ovatum* (Hedw.) Dix. (Plate 6, Figs 1–8)

Autoicous, bulbiform, 0.7 mm high plants. Stem short. Leaves broadly ovate, concave, green–grey with two ventral large green sacs; nerve excurrent forming a long \pm hyaline

hair; leaf 1.3 mm long excluding its hair; hair 0.8 mm long; leaves readily separable from stem; upper cells quadrate–rectangular; lower cells broadly rectangular; apical marginal cells papillose. Seta 3–4 mm long; capsule oval, slightly under 1 mm long, gymnostomous with wide mouth; lid with oblique rostrum; calyptra cucullate, up to 1.8 mm long.

University grounds at Khaldiya, in shade on garden soil in association with *Pottia* species, 14 Jan. 1976.

Wadi Al-Batin, on sandy soil among rocks, 18 April 1976.

(Europe, Israel, Syria, Jordan, Turkey, Persia, Iraq, Caucasus, Algeria, Morocco, N. America.)

7. *Pottia davalliana* (Sm.) C. Jens. (Plate 7, Figs 1–11)

Small plants, 3–4 mm high, of bright green colour; costa of dark green colour. Leaves ovate–lanceolate, up to 1 mm long; costa excurrent as a mucro; upper marginal cells papillose; lower marginal cells smooth; seta under 4 mm in length; capsule oval to cylindrical, 1.2 mm long, thin-walled, gymnostomous; spores with dense papillae; calyptra cucullate, 1.2 mm long.

Wadi Umm Al-Rimam, not uncommon, at cleft margins and in shade among rocks, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, and 21 Feb. 1978.

University grounds at Khaldiya, in shade on garden soil in association with *Pottia starckeana*, *P. lanceolata* and *Pterygoneurum*, 2 March 1976.

(Europe, Algeria, Madeira, Persia, Iraq, Palestine, N. America, Australia.)

8. *Aloina rigida* (Hedw.) Limpr. (Plate 8, Figs 1–9)

Dioicous, gregarious or occasionally solitary among other mosses. Leaves stout, rigid, short oblong–lanceolate; apex rounded obtuse; base \pm hyaline; ventral surface dark green with a brownish tip; dorsal surface with broad nerve that is yellowish in its upper half and becomes brown at apex; nerve broad, densely covered on ventral surface except at base, with branched chlorophyllose filaments; margins incurved covering the chlorophyllose filaments. Seta up to 15 mm long; capsule brown, long–elliptical, 4–5 mm long; lid long oblique, up to 1.7 mm in length; peristome teeth up to 1.5 mm long, strongly twisted; calyptra cucullate, 3.7 mm long.

Very common and conspicuous, covering comparatively wide areas on and among rocks. Commonly fruiting.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977 and 21 Feb. 1978.

Wadi Al-Batin, 18 April 1976.

(Europe, Iraq, Syria, Lebanon, Israel, Turkey, Caucasus, C. Asia, China, Canaries, Egypt, Algeria, Tunisia, N. America.)

9. *Crossidium squamigerum* (Viv.) Jur. (Plate 9, Figs 1–11)

Autoicous, small branched plants, ca. 4 mm high, olive green when young and dark green when mature. Leaves concave with a mass of branched chlorophyllose filaments on the adaxial surface of the upper half of the nerve; nerve excurrent as a long \pm hyaline hair possessing tiny spines; lower leaves broader than the upper and possess

longer hairs that reach 2.2 mm in length. Seta 12–15 mm long; capsule brown, cylindrical, ca. 3.8 mm long; lid reddish, 1 mm long; peristome twisted, 0.8 mm long; calyptra reddish, cucullate, 4.2 mm long.

Abundant and conspicuous and, like *Aloina*, covers comparatively wide areas on and among rocks. Commonly fruiting.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977 and 21 Feb. 1978.

Wadi Al-Batin, 18 April 1976.

(Europe, Israel, Lebanon, Syria, Jordan, Turkey, Iraq, Persia, Caucasus, Egypt, Algeria, Morocco, N. America.)

10. *Crossidium chloronotos* (Brid.) Limpr. (Plate 10, Figs 1–7)

Dioicous, small, pale green plants. Upper leaves narrower with shorter hairs; hairs smooth, ca. 0.25 mm long in upper leaves and 0.75 mm in lower leaves, and easily break off. Leaves concave with ventral branched chlorophyllose filaments on the apical part of the nerve; nerve more green than sides of the lamina. Seta short, under 5 mm in length; capsule cylindrical-oblong, brown, ca. 2.5 mm long; peristome 0.5 mm long; calyptra 2.5 mm long.

Common on sandy soil on and among rocks, at cleft margins and extends but little to just inside crevices.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977 and 21 Feb. 1978.

Wadi Al-Batin, 18 April 1976.

(Mediterranean Europe, Israel, Syria, Iraq, Caucasus, Afghanistan, Egypt, Algeria, Canaries, Madeira, ?N. America, ?New Zealand.)

11. *Trichostomopsis haussknechtii* (Jur. et Milde) S. Agnew & Townsend (Plate 11, Figs 1–7)

Branched caespitose plants, ca. 10 mm high, olive green with brownish basal parts. Leaves crowded, patent or erecto-patent, lingulate or lanceolate, 1.8 mm long, concave with slightly incurved tips; apex obtusely acute; margin \pm smooth, mostly recurved; costa terminating vaguely in or just below apex. Upper lamina cells irregularly quadrate or triangular or rounded, chlorophyllose; basal lamina cells rectangular, hyaline. Acrocarpous but lateral branches grow over the one carrying the sporophyte; seta smooth, red-brown, flexuose, erect or inclined or curved, up to 13 mm long; capsule erect or slightly curved, brown, ovate-oblong or cylindrical-oblong, 2.7 mm long; peristome 0.4 mm long, very light brown, slightly twisted; lid with oblique beak, hardly exceeding 1 mm in length; calyptra cucullate, up to 2.3 mm long, light brown or yellowish.

A rare plant, collected from only one spot, in shade among rocks. Fruiting plants not numerous.

Wadi Umm Al-Rimam, 5 March 1976.

(Iraq, Persia, Afghanistan.)

12. *Tortula atrovirens* (Sm.) Lindb. (Plate 12, Figs 1–10)

Dioicous, ca. 4 mm high plants. Leaves oblong, 1.7 mm long, bright green when young, darker when mature, crowded in a whorl at stem apex; nerve distinct, broader in the

upper part of the leaf, excurrent as a mucro; apical marginal cells smooth; upper cells quadrate-rounded, chlorophyllose; basal cells rectangular, hyaline. Seta brownish, 1 cm long; capsule oblong, 2.3 mm long, brownish; peristome red-brown, 0.3 mm long; lid with oblique beak, 0.5 mm long; calyptra mitriform, 1.9 mm long, dark brown.

Common among rocks, less common on rocks, frequently fruiting.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977, and 21 Feb. 1978.

Wadi Al-Batin, 18 April 1976.

(Europe, Syria, Jordan, Israel, Iraq, Afghanistan, Caucasus, Kashmir, Sahara, Tunisia, Algeria, Azores, C. America, New Zealand, Australia.)

13. *Physcomitrium pyriforme* (Hedw.) Hamp. (Plate 13, Figs 1-8)

Autoicous, gregarious, 5 mm high plants. Leaves lanceolate, somewhat concave, denticulate, up to 4 mm long, crowded in a whorl at apex of stem; apex acute with a sharp point; nerve thin, excurrent; cells large, mainly rectangular. Seta ca. 6 mm long; capsule gymnostomous, pyriform, erect, symmetrical; lid conical; calyptra mitriform.

An introduced plant growing on soil in greenhouses of the Department of Agriculture in Kuwait. Specimens were collected in Feb. and March 1975-78.

(Europe, Asia, Africa, Egypt, Australia.)

14. *Funaria hygrometrica* Hedw. (Plate 14, Figs 1-9)

Autoicous; male branches ca. 4 mm long; female branches ca. 8 mm long. Leaves broad, ovate or spatulate, up to 4 mm long, concave, crowded at stem apex in a whorl; nerve thin, distinct, excurrent into a short acute apex. Seta long, arcuate, ca. 3 cm long; capsule pyriform, curved, asymmetric; peristome twisted; mouth under 1 mm in diameter; lid convex; calyptra cucullate, ca. 5 mm long.

Plants growing in tufts on muddy and sandy soil in shaded areas in some gardens in Kuwait and also in greenhouses of the Department of Agriculture at Farawaniya. Probably introduced. Specimens were collected in Feb. and March 1975-78.

(Cosmopolitan, Egypt, Lebanon, Jordan, Syria, Israel, Turkey, Iraq, Persia, Afghanistan.)

15. *Bryum* sp. (Plate 15, Figs 1-6)

Leaves ovate or oblong-lanceolate, concave with acuminate apex, 1.4 mm long, crowded and overlapping at stem apex, light green to dark green; nerve distinct, green, excurrent.

Numerous brown-coloured, readily detachable gemmae are borne on the rhizoids. Gemma 0.2 mm in diameter. Under unfavourable conditions stems are short, 1.5 mm long; leaves thickly overlapping, dark and efficiently protecting the stem apex (almost like a dormant covered bud of higher plants). Under favourable conditions innovations occur and new stem extensions are ca. 6 mm long with less crowded leaves.

The most widespread moss in Kuwait, found in winter in almost every garden, in greenhouses, in wadis and in a few desert areas.

University garden at Shuwaikh, Nov. and Dec. 1974. Collections were made from these and other gardens and greenhouses throughout the seasons of 1975-78.

Wadi Umm Al-Rimam, 12 and 27 Feb., 8 May 1975, 26 Jan., 5, 23 and 26 March 1976, 2 March 1977 and 21 Feb. 1978.

Al-Dbā'iyya, 12 Jan. 1976.

Wadi Al-Batin, 18 April 1976

Tamarisk forest near Jahra, on sandy soil in shade under tamarisk trees, 10 Nov. 1977.

16. *Leptobryum pyriforme* (Hedw.) Wils. (Plate 16, Figs 1–8)

Weed-like plants, ca. 6.5 mm high. Stems weak. Leaves narrow, almost filiform, much longer and more crowded at stem apex; upper leaves ca. 3 mm long; antheridia axillary, bud-shaped, brown, stalked. Seta ca. 2 cm long, flexuose, bent; capsule elongate-pyriform; calyptra 2 mm long.

An introduced plant growing on soil in greenhouses of the Department of Agriculture at Farawaniya. Specimens collected in Feb. and March 1975–78.

(Europe, Africa, America, Australia.)

It is worth mentioning that a great variety of colourful lichens occur on and among rocks in association with the wadi mosses, but no hepatics were ever found during all the seasons of collection. All mosses and lichens of the wadis occur on north or northwest-facing slopes. The latter are more shaded and gain more water from rain than the opposite slopes because rain is driven against them by the prevailing cold winter winds blowing from the northwest. A brief description of the four rainy seasons 1975–78 and their effect on the growth of mosses is tabulated below.

In the poor season of 1977 the few rain showers hardly sustained the life of wadi mosses which have more access to the rain than those growing on and among rocks and

Table 1. Rain and its effect on the growth of garden and wadi mosses

Year (winter)	Rainy season	Garden mosses	Wadi mosses (Umm Al-Rimam area)
1975	Moderate	Only 2 species recorded. <i>Bryum</i> : not widespread; <i>Funaria</i> : poor & no fruit	10 species recorded
1976	Favourable	6 species recorded. <i>Bryum</i> : widespread; <i>Funaria</i> : gave fruits; <i>Pterygoneurum</i> and 3 species of <i>Pottia</i> recorded only in this season	12 species recorded. <i>Timmiella</i> and <i>Trichostomopsis</i> recorded only in this season; <i>Gymnostomum</i> gave fruits only in this season; Other normally fruiting species gave more fruits in this season
1977	Poor	2 species only. <i>Bryum</i> : poor; <i>Funaria</i> : sparse	7 species recorded. The missing species were: <i>Fissidens</i> , <i>Gymnostomum</i> , <i>Timmiella</i> , <i>Pottia</i> and <i>Trichostomopsis</i>
1978	Heavy rain but interrupted by long dry periods	The same results as for 1975	The same results as for 1975

there was not enough water to gather in the crevices. The latter were dry and without any green cover of mosses. This explains the disappearance of mosses which grow only inside the crevices, e.g. *Fissidens*, *Timmiella*, as shown in the table.

The maximum number of moss species was recorded in the favourable rainy season of 1976. That season brought also the maximum number of fruiting species. Not only that but also during that same season peculiar brown-coloured protonemata were developed by stems of a number of species which grow inside the wet crevices. The protonemata arose in the axils of the upper leaves of the stem and extended vertically in the air for several centimetres above the plants (Plate 17, Figs 3, 4). These peculiar protonemata have been investigated and the results will be published in a separate communication.

As already mentioned, mosses in such desert countries as Kuwait are not widespread. However, no claim whatsoever is made here that there is no chance for more records to be made. On the contrary, further collections would certainly be fruitful. They could also succeed in locating the moss whose leaves are shown on Plate 17, Figs 1 and 2. These leaves are similar to those of certain species of *Tortula* (e.g. *T. muralis*) or perhaps more close to species of *Syntrichia*. The specimen from which these two leaves were taken was found in association with *Crossidium squamigerum* collected from wadi Umm Al-Rimam on 27 February 1975. Reinvestigation of the collection of that year and also of successive years might be worthwhile.

All moss specimens are deposited at the Botany and Microbiology Department, Kuwait University.

ACKNOWLEDGEMENT

I wish to thank Dr S. Agnew (of Wales University, Aberystwyth) for interest, for kind help through sending me a copy of her publications especially that on the moss flora of Iraq, and for kindly identifying moss specimens. Thanks are also due to Professor M. Bizot (of Dijon, France) for kindly identifying most of the moss specimens. Thanks are extended to Professor R. Halwagy (Kuwait University) for collection of *Bryum* specimens from near Jahra, to Mr Fahd El-Ouda (Kuwait University) for collection of *Bryum* specimens from Al-Dbā'iyya, and to Mr Rashad Mahmoud (Kuwait University) for collection of greenhouse mosses. Thanks are due also to all who offered help and to Kuwait University for facilities supplied.

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Plate 1

Fissidens obtusifolius

- Fig. 1. Habit of plant. \times ca. 4.
- Fig. 2. Different developmental stages of fruiting plants. \times 6-2.
- Fig. 3. A single gametophyte. \times ca. 37.
- Fig. 4. Vaginant leaf bases. \times ca. 90.
- Fig. 5. A leaf showing apical cells. \times ca. 90.
- Fig. 6. A capsule without lid. \times ca. 32.
- Fig. 7. A younger capsule. \times ca. 36.

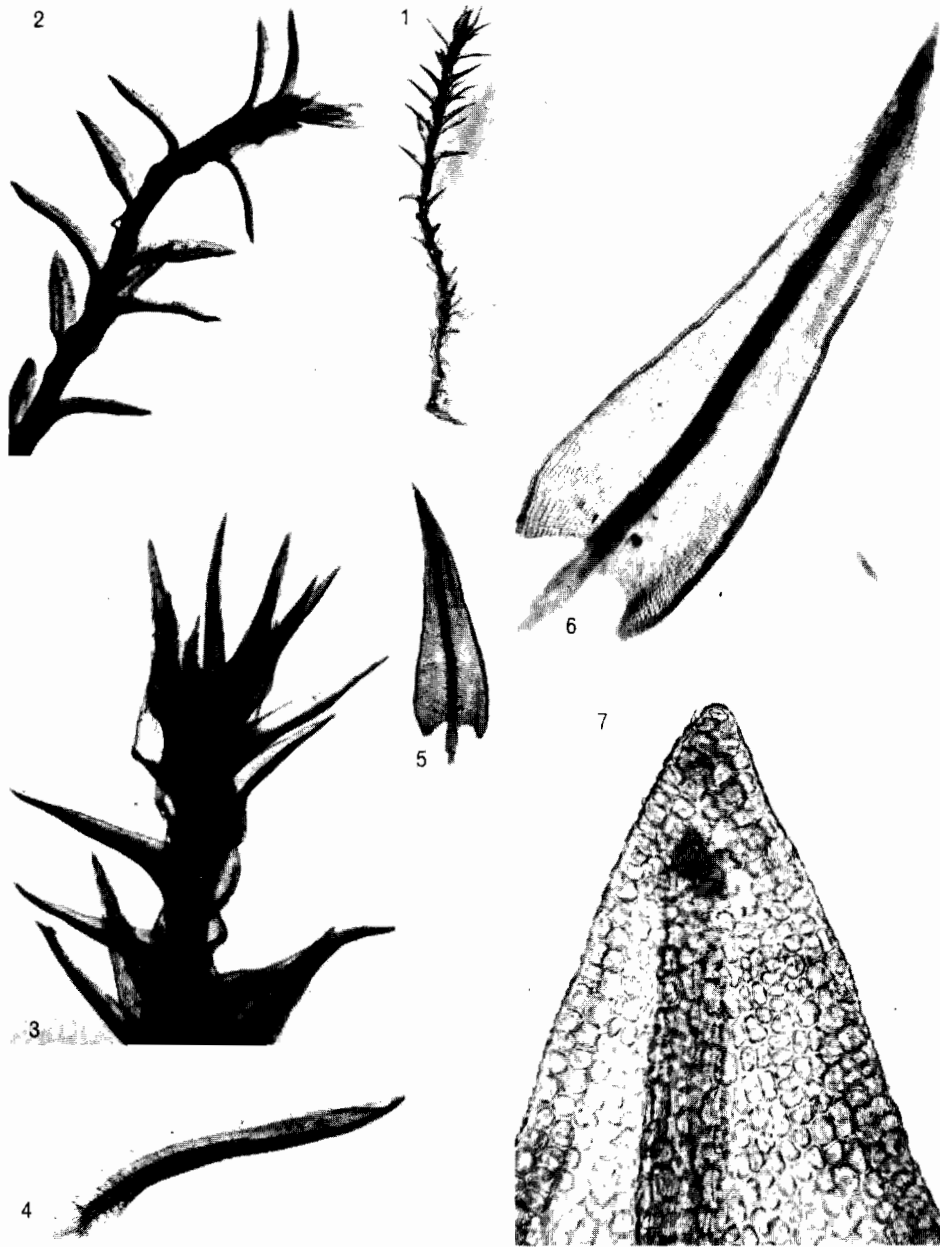


Plate 2

Barbula vinealis

- Fig. 1. A single plant. $\times 7$.
- Fig. 2. Distal part of a young plant. $\times 33$.
- Fig. 3. Distal part of older plant showing imbricate leaves. $\times 33$.
- Fig. 4. Leaf in side view. $\times 33.3$.
- Fig. 5. Leaf in surface view. \times ca. 36.
- Fig. 6. The same. \times ca. 95.
- Fig. 7. Cells at leaf apex. \times ca. 400.

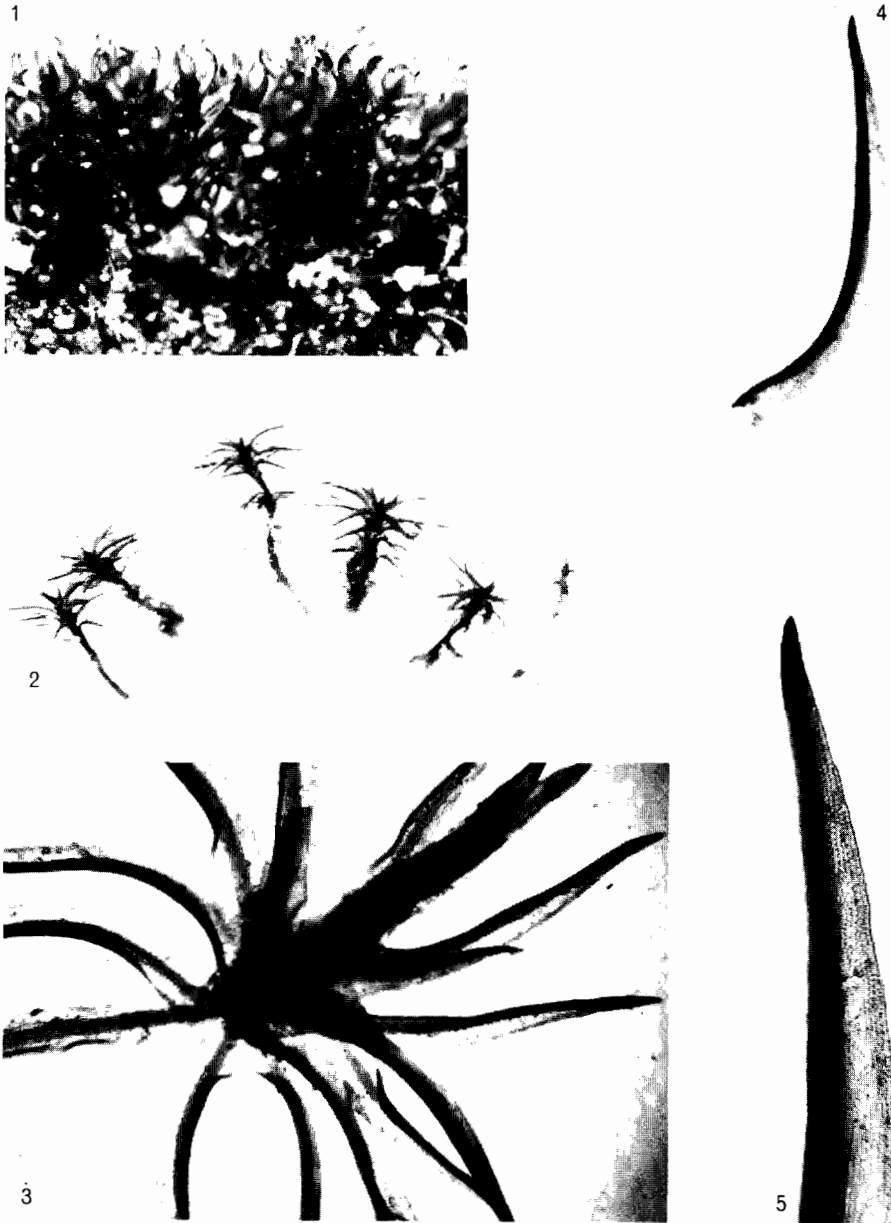


Plate 3

Barbula sp.

- Fig. 1. Tufted growth of plants on soil. \times ca. 6.
- Fig. 2. Plants showing apical 'crown' of leaves. \times 7.
- Fig. 3. Top view of a plant. \times 35.
- Fig. 4. Leaf in side view. \times 35.
- Fig. 5. Apical part of the same. \times ca. 91.

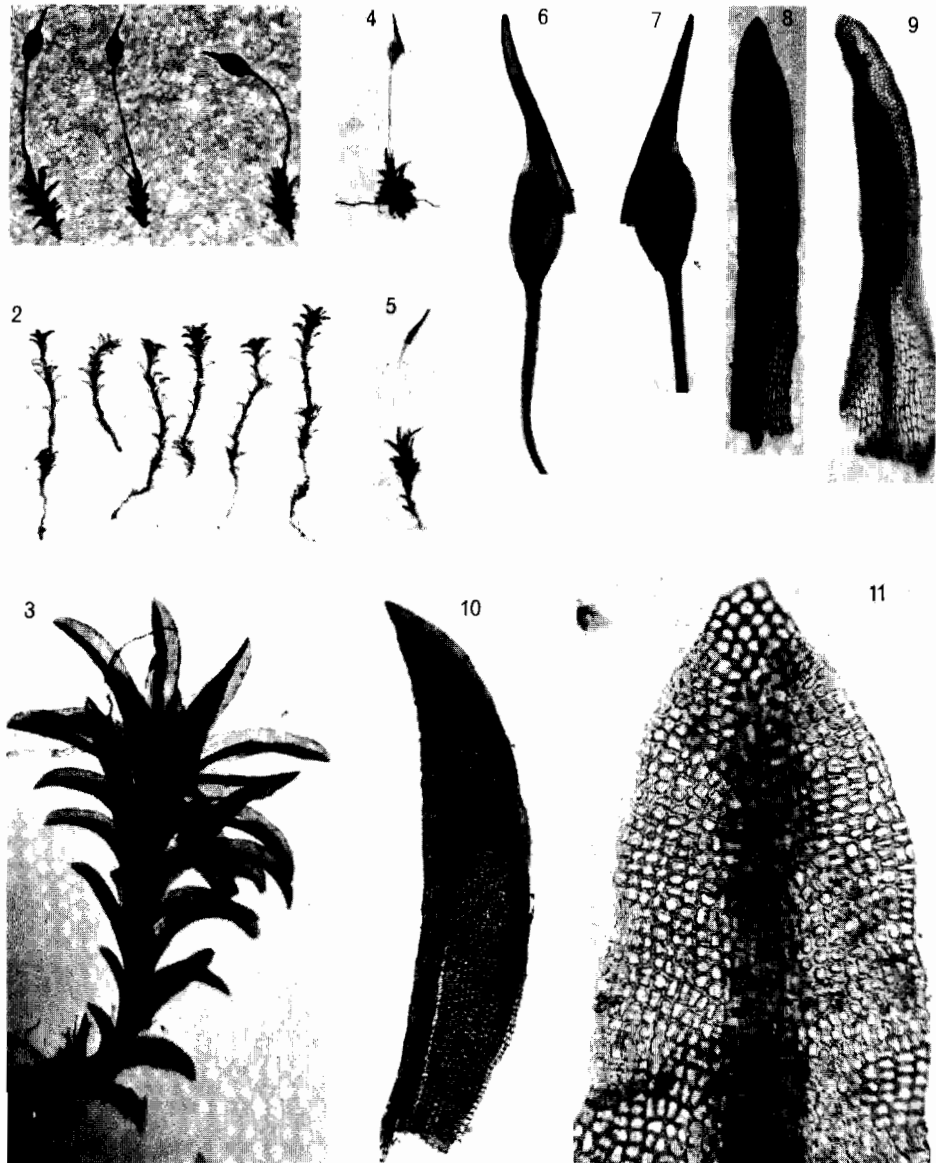


Plate 4

Gymnostomum calcareum

- Fig. 1. A group of fruiting plants. $\times 6.5$.
 Fig. 2. A group of young plants. $\times 6.5$.
 Fig. 3. One plant showing upper longer leaves. $\times ca. 33$.
 Fig. 4. Plant with immature sporophyte. $\times 6$.
 Fig. 5. Plant with young sporophyte. $\times ca. 6$.
 Fig. 6. Immature capsule with calyptra. $\times 30$.
 Fig. 7. An older capsule with calyptra. $\times 30$.
 Fig. 8. Leaf in surface view. $\times ca. 70$.
 Fig. 9. Leaf showing basal cells. $\times ca. 90$.
 Fig. 10. Leaf in side view. $\times ca. 130$.
 Fig. 11. Upper cells of leaf. $\times ca. 335$.

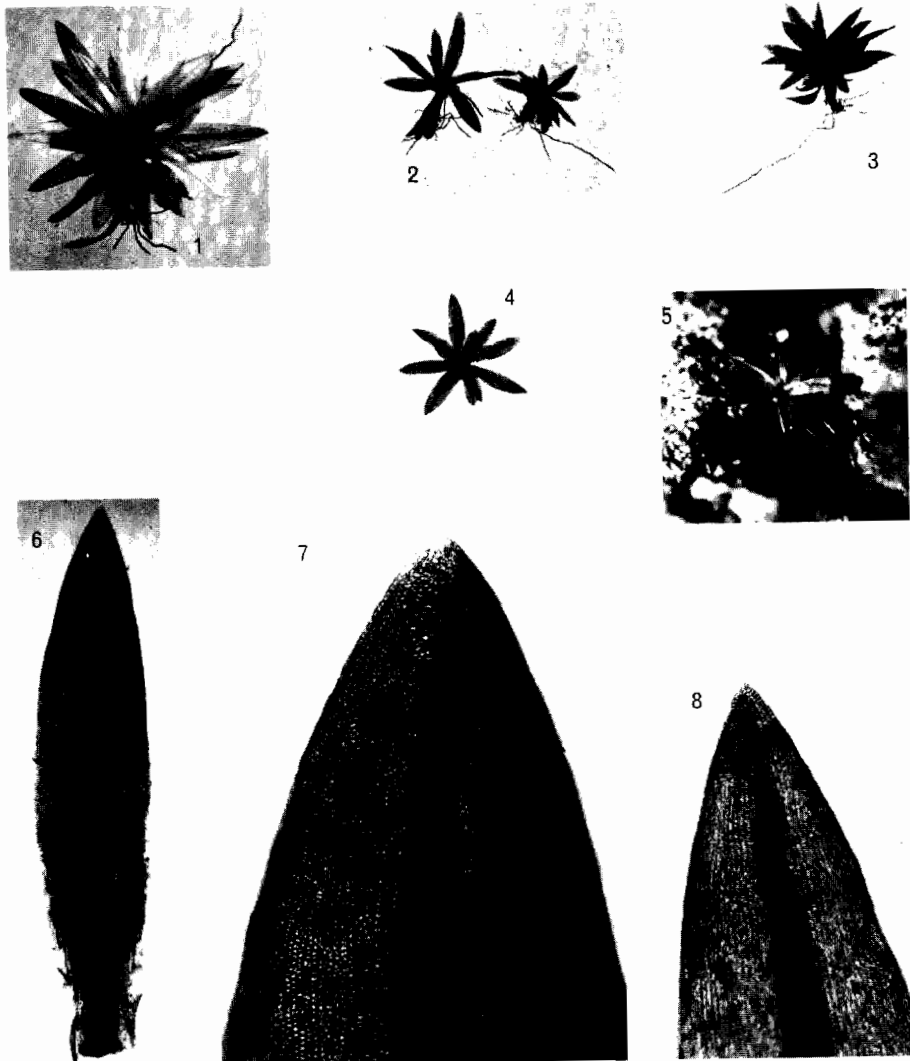


Plate 5

Timmiella anomala

Figs 1–4. Different views of different stages of growth of plants. Fig. 1. $\times 6.8$, Figs 2–4 $\times 4$.

Fig. 5. A solitary plant emerging from a soil crack. \times ca. 5.5.

Fig. 6. Leaf in surface view. $\times 31.7$.

Fig. 7. Apical part of leaf, much enlarged.

Fig. 8. Upper part of leaf showing marginal apical cells. \times ca. 86.



Plate 6

Pterygoneurum ovatum

Figs 1-4. Plants bearing sporophytes in different stages of growth. Fig. 1. \times ca. 33, Fig. 2 \times ca. 5, Fig. 3 \times 6, Fig. 4 \times ca. 6.

Fig. 5. Calyptra with lid. \times ca. 28.

Figs 6 & 7. Surface view of two different leaves, both \times 30.

Fig. 8. Upper part of leaf showing characteristic features. \times ca. 75.



Plate 7

Pottia davalliana

Figs 1–4. Different views of leaves in different stages of growth, Fig. 1. \times ca. 90, Fig. 2. \times ca. 86, Fig. 3. \times ca. 30, Fig. 4. \times ca. 90.

Figs 5–8. Plants bearing sporophytes in different stages of growth. Fig. 5. \times ca. 33, Fig. 6 \times ca. 6, Fig. 7 \times 6, Fig. 8 \times 7.

Fig. 9. Calyptra. \times ca. 33.

Figs 10 & 11. Two capsules in different stages of growth, both \times ca. 33.

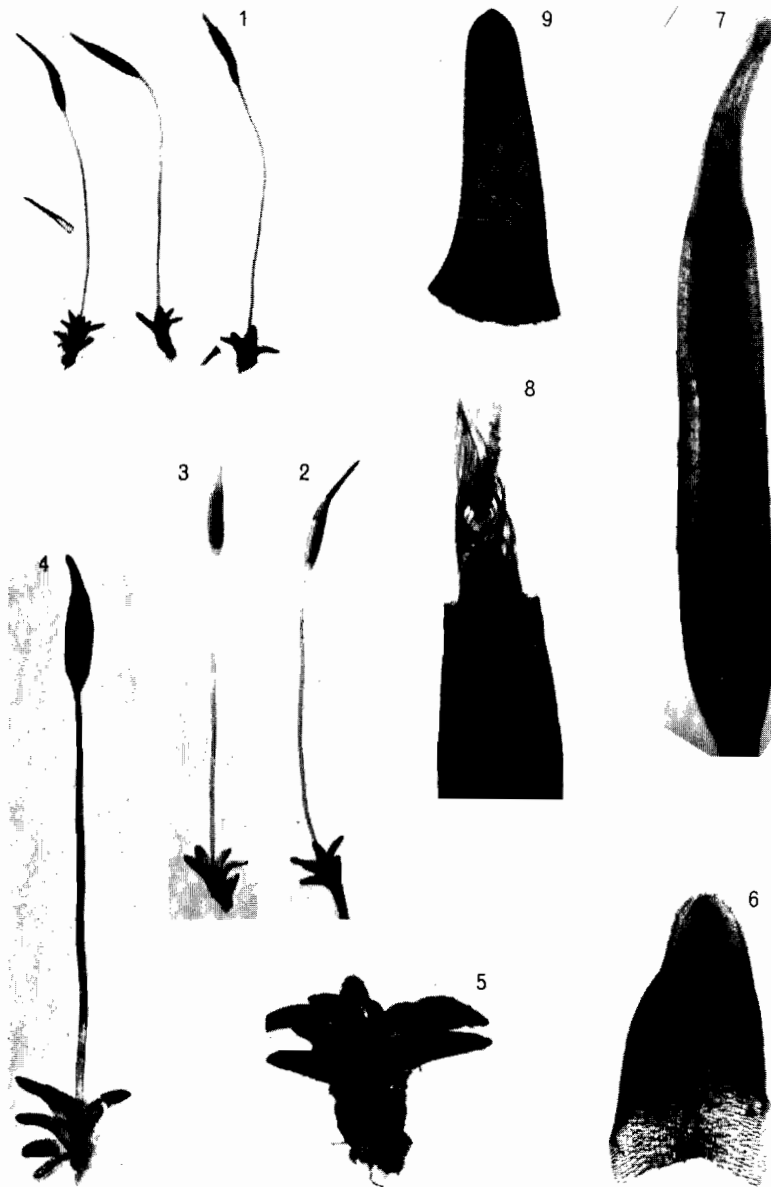


Plate 8

Aloina rigida

- Fig. 1. Three fruiting plants, a detached lid and calyptra are also shown. \times ca. 3.
Figs 2-4. Different growth stages of fruiting plants. Figs 2 & 3 \times 4, Fig. 4 \times ca. 6.3.
Fig. 5. Plant showing stout leaves. \times ca. 10.
Fig. 6. Leaf in surface view. \times ca. 33.
Fig. 7. Immature capsule. \times ca. 33.
Fig. 8. Twisted peristome. \times ca. 33.
Fig. 9. Lid. \times ca. 31.

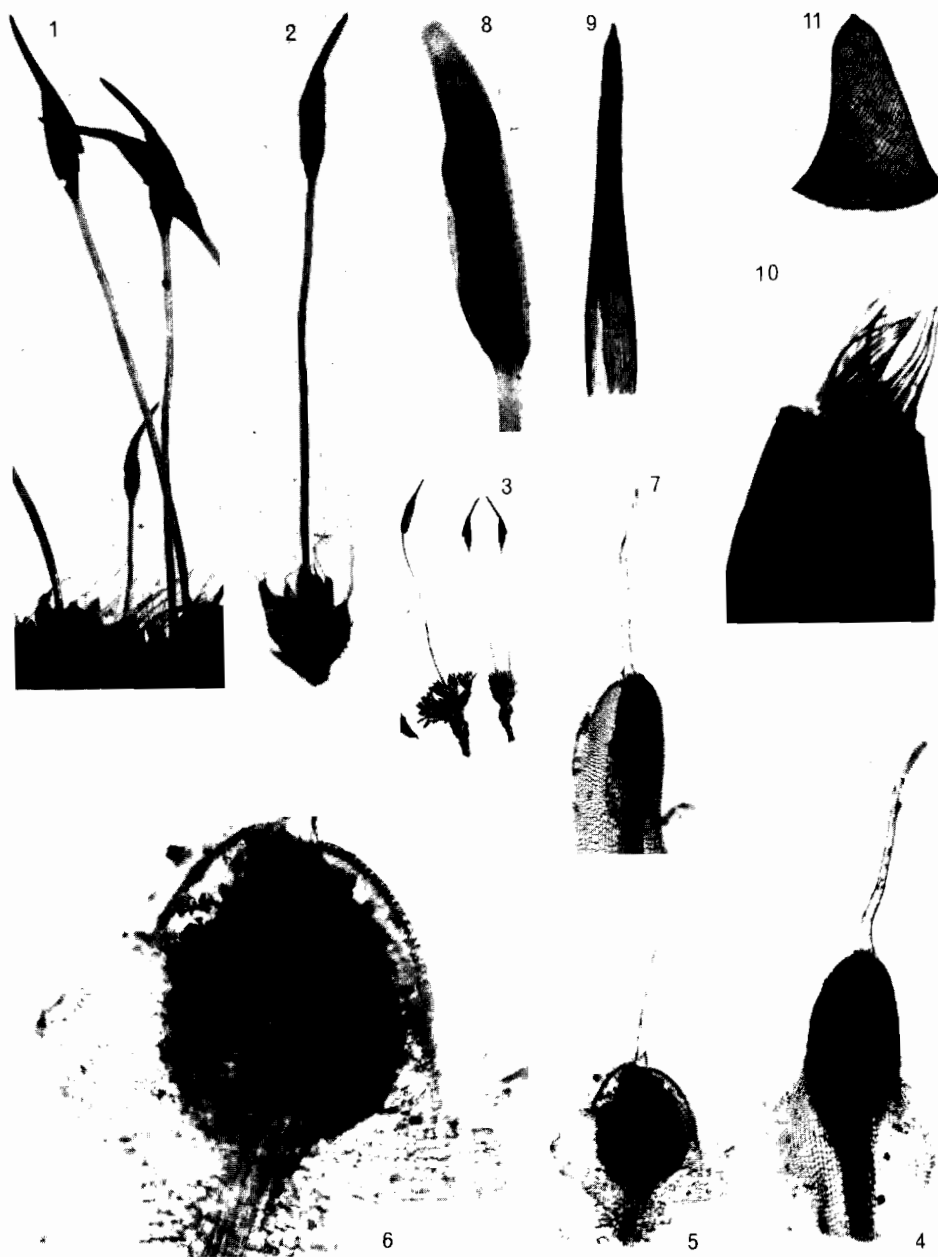


Plate 9

Crossidium squamigerum

- Fig. 1. Plants growing on soil. \times ca. 6.
 Fig. 2. A single fruiting plant. \times ca. 6.
 Fig. 3. Two fruiting plants showing manner of branching. \times 2.1.
 Fig. 4. Leaf in surface view. \times 30.
 Fig. 5. One of the lower leaves of a stem. \times ca. 33.
 Fig. 6. Part of the same. \times ca. 88.
 Fig. 7. Apical part of an upper leaf of the same stem. \times ca. 35.
 Fig. 8. Immature capsule. \times ca. 33.
 Fig. 9. Calyptra. \times 31.
 Fig. 10. Peristome. \times ca. 30.
 Fig. 11. Lid. \times 33.



Plate 10

Crossidium chloronotos

- Fig. 1. A fruiting plant with capsule and calyptra: $\times 6.7$.
 Fig. 2. A fruiting plant showing peristome. $\times 5$.
 Fig. 3. One of the lower leaves of plant of Fig. 1. $\times ca. 33$.
 Fig. 4. The same; apex and hair. $\times ca. 88$.
 Fig. 5. One of the upper leaves of the same plant. $\times ca. 35$.
 Fig. 6. Upper part of the same. $\times ca. 93$.
 Fig. 7. Branched chlorophyllose filaments of the ventral surface of the leaf, much enlarged.

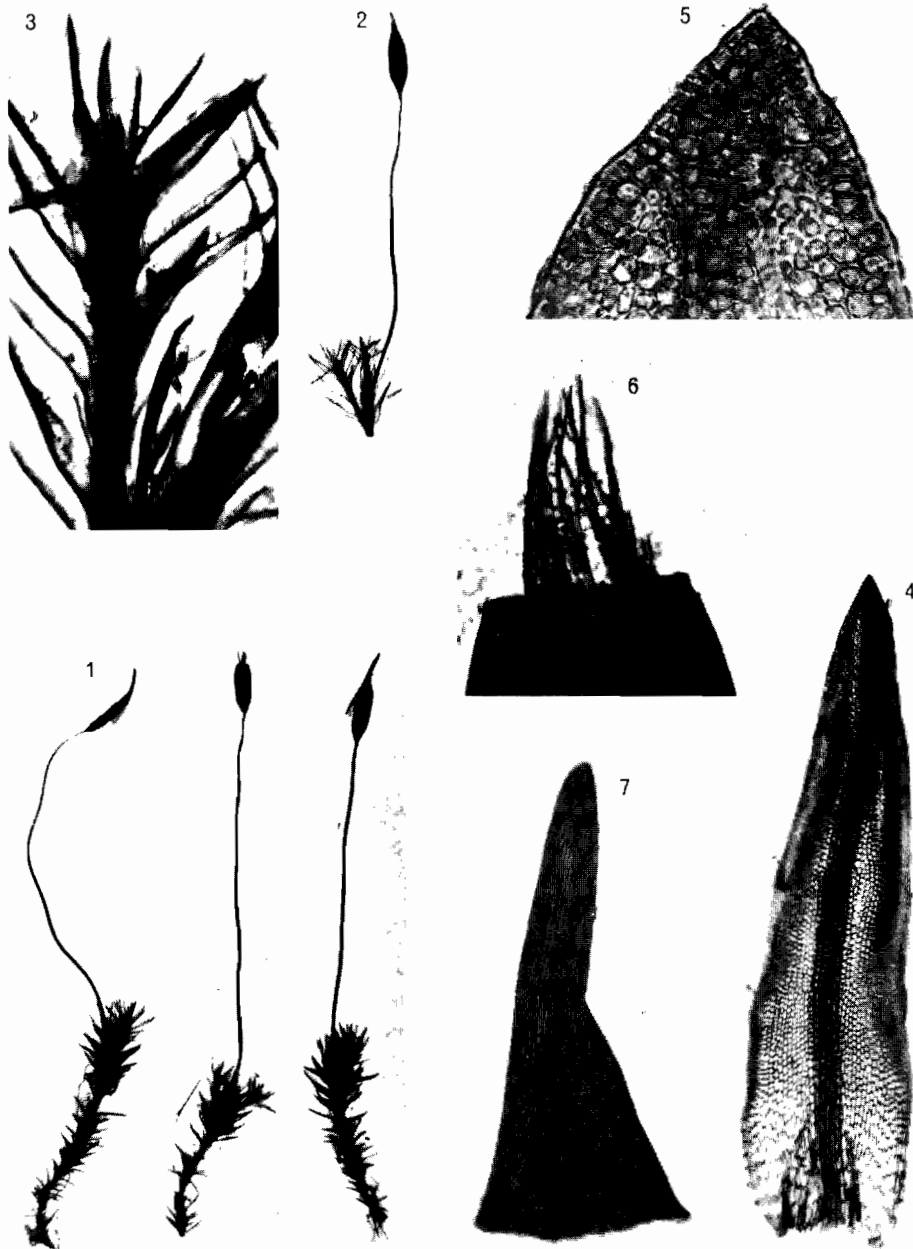


Plate 11

Trichostomopsis haussknechtii

- Fig. 1. Three fruiting plants, the middle one shows peristome. \times ca. 5.
 Fig. 2. Sterile branches growing over the fertile one. \times 5.
 Fig. 3. Distal portion of a branched plant. \times ca. 30.
 Fig. 4. Leaf in surface view. \times ca. 87.
 Fig. 5. Leaf apex. \times ca. 300.
 Fig. 6. Peristome. \times 90.
 Fig. 7. Lid. \times ca. 74.

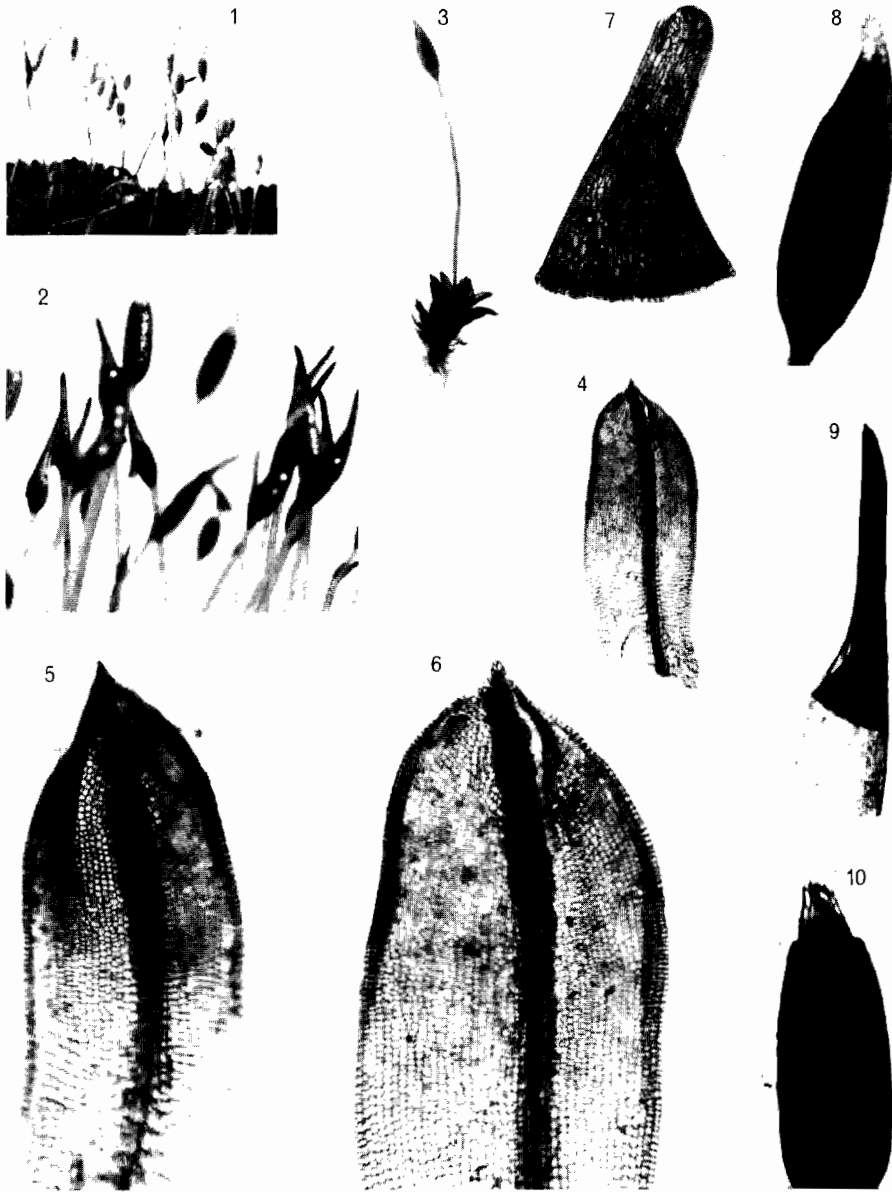


Plate 12

Tortula atrovirens

- Fig. 1. A group of fertile plants showing growth habit. \times ca. 2.5.
- Fig. 2. Distal portions of the same. \times ca. 9.
- Fig. 3. A single fruiting plant. \times ca. 6.
- Fig. 4. Leaf in surface view. \times ca. 38.
- Fig. 5. Part of a leaf showing small upper cells and larger lower cells. \times ca. 75.
- Fig. 6. Mucronate leaf apex and marginal cells. \times ca. 100.
- Fig. 7. Lid. \times ca. 100.
- Fig. 8. Capsule. \times ca. 33.
- Fig. 9. Calyptra withholding lid. \times ca. 35.
- Fig. 10. Peristome. \times ca. 35.



Plate 13

Physcomitrium pyriforme

- Fig. 1. A single plant. $\times 5$.
- Fig. 2. The same. $\times 6$.
- Fig. 3. Capsule. $\times 6-7$.
- Fig. 4. Plant with open capsule, lid and calyptra also shown. $\times 4$.
- Fig. 5. A complete fruiting plant. $\times 3-7$.
- Fig. 6. Leaf apex. \times ca. 100.
- Fig. 7. Upper half of leaf. $\times 40$.
- Fig. 8. Whole leaf in surface view. $\times 40$.

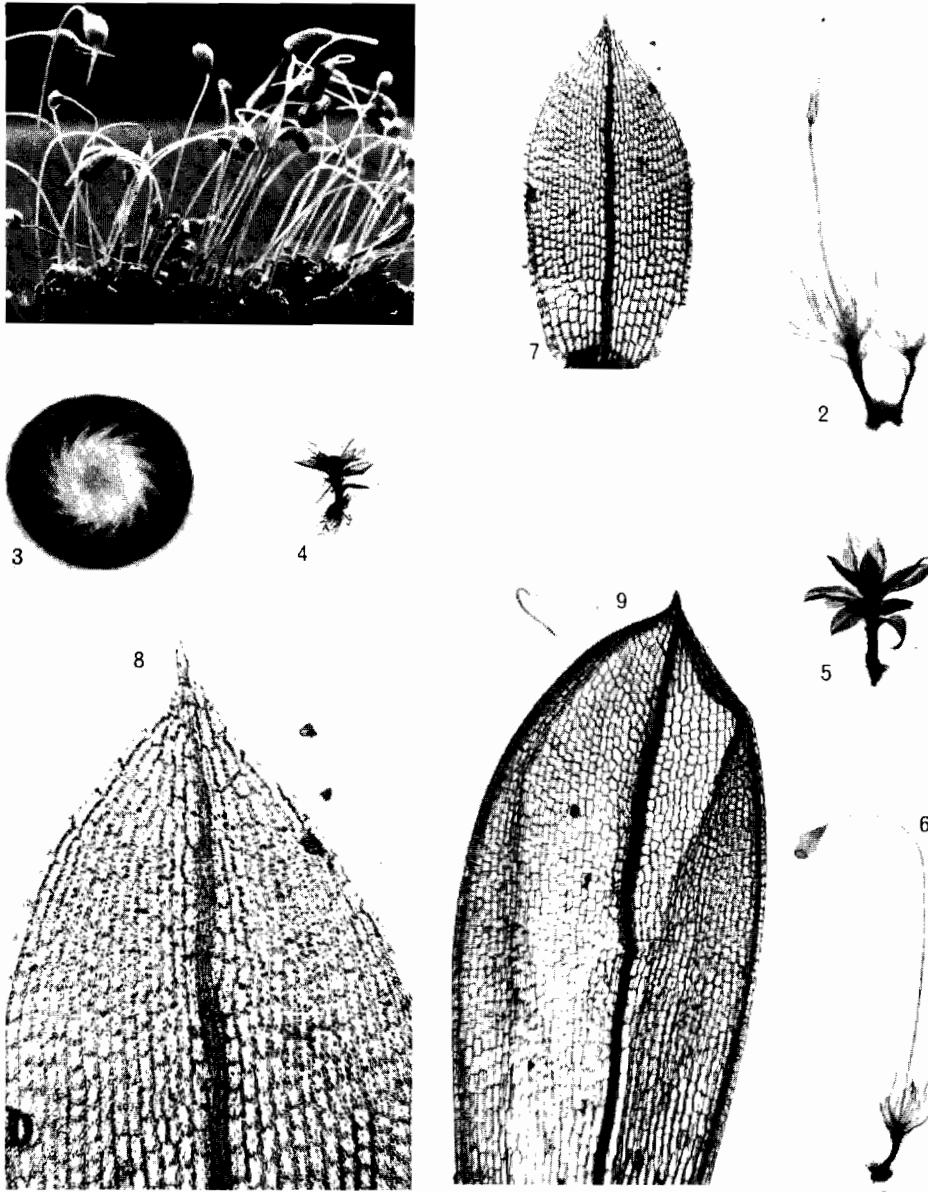


Plate 14

Funaria hygrometrica

- Fig. 1. Habit of plants in fruit. \times ca. 2.7.
 Fig. 2. Small male branch and large female branch bearing immature sporophyte. \times 4.
 Fig. 3. Top view of lid showing peristome underneath. \times 40.
 Fig. 4. Plant with antheridial head. \times ca. 3.
 Fig. 5. A female branch. \times 6.7.
 Fig. 6. Arcuate seta. \times 2.75.
 Fig. 7. A young leaf in surface view. \times 40.
 Fig. 8. Upper part of the same. \times ca. 100.
 Fig. 9. Upper part of older leaf. \times 40.

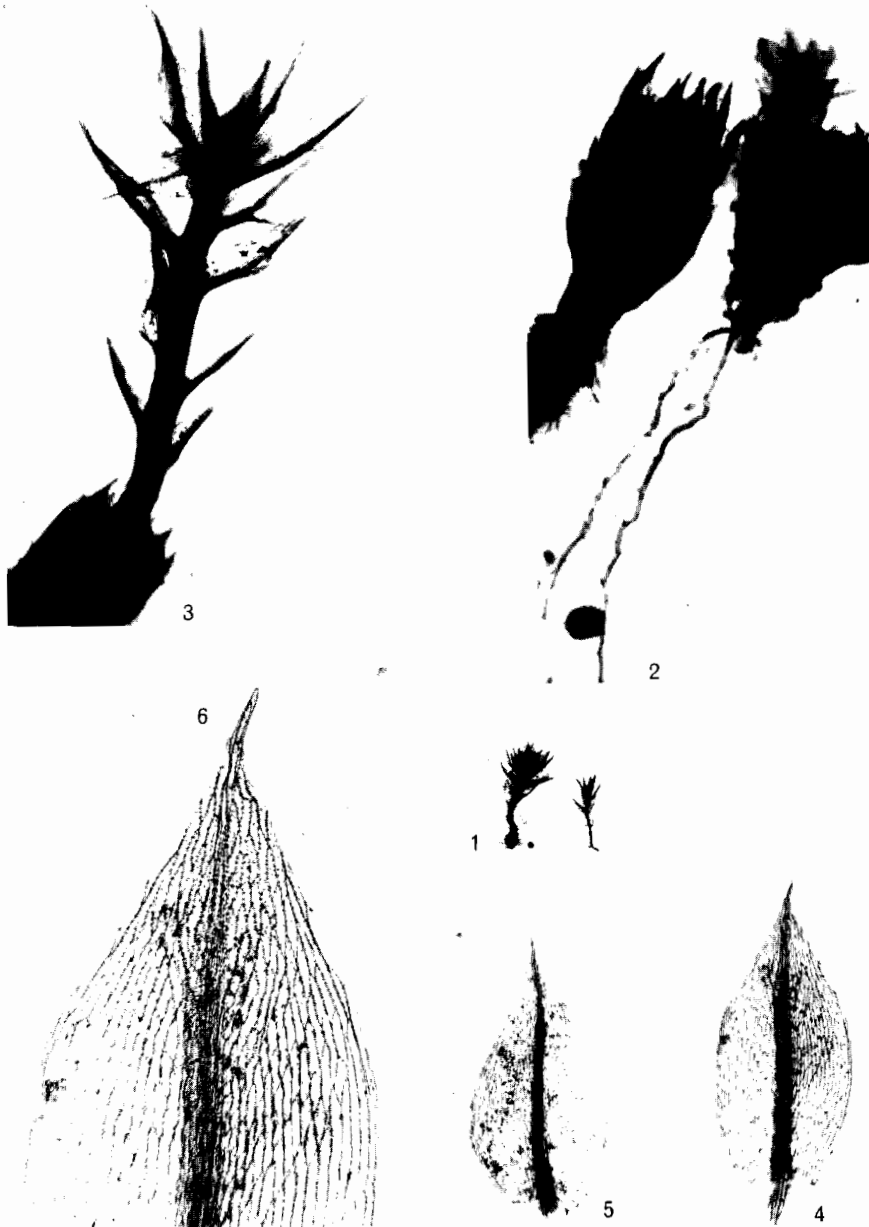


Plate 15

Bryum sp.

- Fig. 1. Two plants, the older bearing a gemma on rhizoid. \times ca. 5.
 Fig. 2. Two plants, one with a gemma and stem innovation. \times ca. 33.
 Fig. 3. Innovation, crowded dark leaves of old stem at base. \times ca. 33.
 Fig. 4. Leaf in surface view. \times ca. 37.
 Fig. 5. A second leaf showing a somewhat different shape. \times ca. 37.
 Fig. 6. Apex of the leaf of Fig. 4. \times ca. 92.

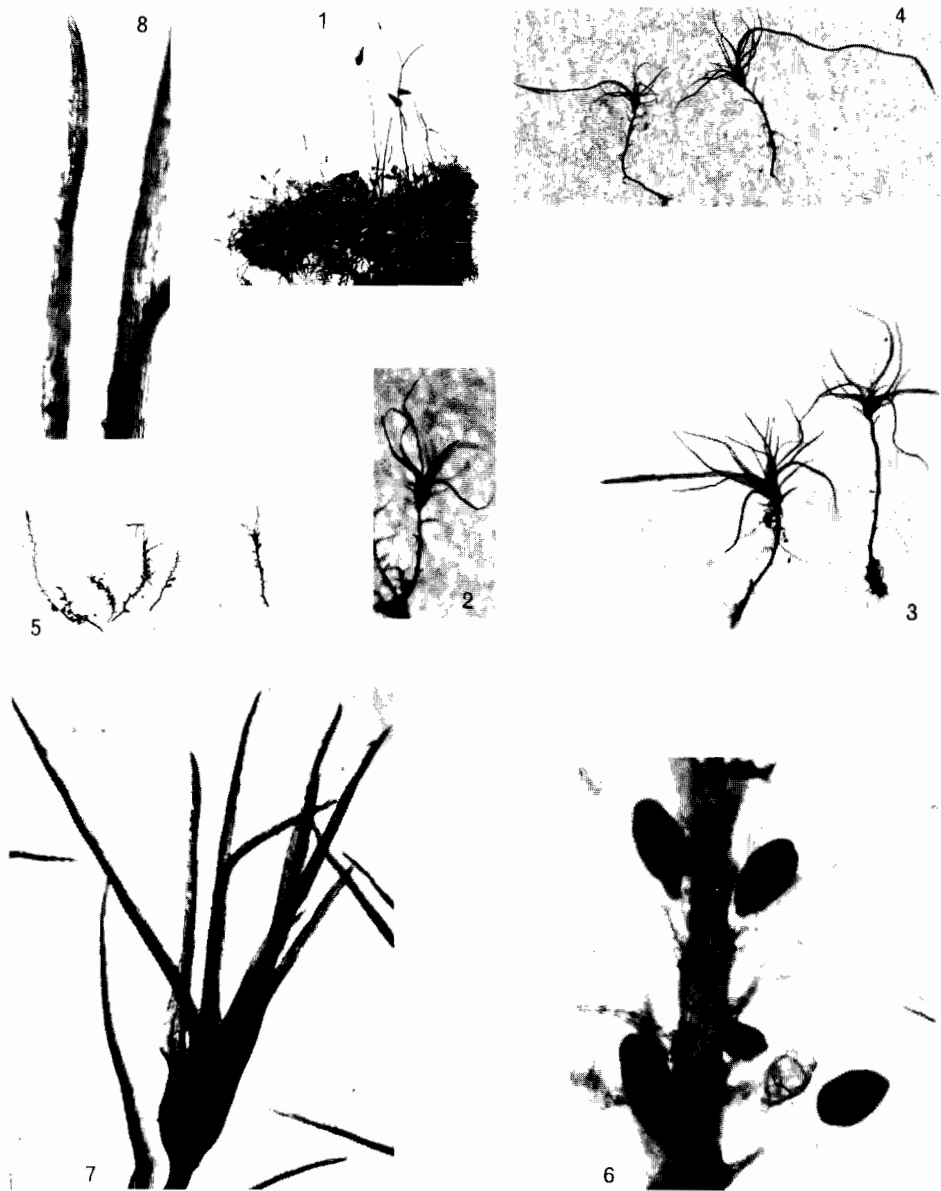


Plate 16

Leptobryum pyriforme

Fig. 1. Habit of fruiting plants. \times ca. 1-5.

Figs 2-4. Plants bearing sporophytes in different stages of growth. Fig. 2 \times ca. 6-4, Fig. 3 \times 6, Fig. 4 \times ca. 4.

Fig. 5. A group of plants bearing antheridia. \times 3-75.

Fig. 6. Bud-shaped antheridia in leaf axil. \times ca. 50.

Fig. 7. Distal part of stem. \times ca. 30.

Fig. 8. Distal portions of leaves. \times ca. 50.

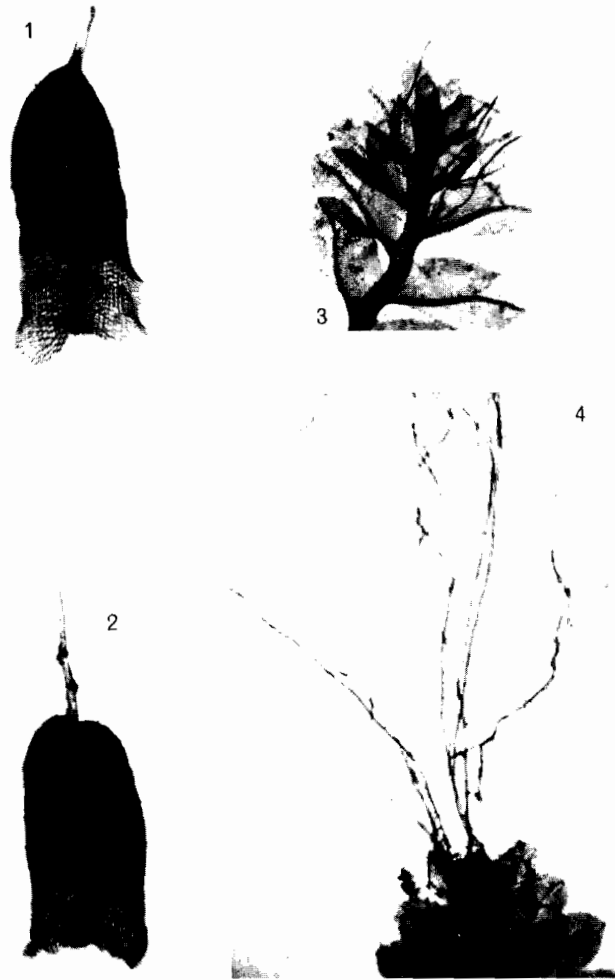


Plate 17

Syntrichia? and *Fissidens*

Fig. 1. Leaf of *Syntrichia?* with short hair. \times ca. 33.

Fig. 2. A second leaf of the same with a longer hair. \times ca. 40.

Fig. 3. *Fissidens obtusifolius* with axillary protonemata. \times ca. 33.

Fig. 4. Extensive vertical growth of protonemata on top of a *Fissidens obtusifolius* plant. \times ca. 33.

نحو فلورة حزازية للكويت

وجيه السيد السعداوى *
قسم النبات والميكروبيولوجيا بجامعة الكويت

خلاصة

لقد تم حتى الان جمع ١٩ نوعا من الحزازيات من الكويت ، ينتمى ١٤ نوعا منها الى الفصيلة البوتياسية . ويشمل هذا لبحث وصفا مصورا لستة عشر نوعا من هذه الفلورة الحزازية من بينها نوعان يجمعان لاول مرة من الكويت .

* العنوان الحالى : قسم النبات بكلية العلوم ، جامعة عين شمس ، العباسية ، القاهرة ، مصر .